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RESEARCH AND DEVELOPMENT TECHNICAL REPORT

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AN APPROACH TO THE SHORT-RANGE PREDICTION OF EARLY MORNING RADIATION FOG

By

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January 1977

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UNITED STATES ARMY ELECTRONICS COMMAND - FORT MONMOUTH, NEW JERSEY 07703

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A simplified approach is presented for the prediction of a 3-hour period between midnight and sunrise during which radiation fog formation will initially restrict prevailing surface visibilities to less than 1 statute mile.

This approach considers the cooling below the dew point necessary to provide sufficient condensed moisture (0.5 gram of liquid water per kilogram of air) to form the restricting fog condition. → next page

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20. ABSTRACT (cont)

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A prediction verification of 71 percent was obtained from a total of 52 test cases in the Texas-Oklahoma area during the period 25-28 February 1973.

CONTENTS

INTRODUCTION

Meteorological support for military purposes should be designed not only to assure tactical operational safety but also to enable effective exploitation of weather information in air and ground operations.

Without tactical air superiority, maximum use of cloud cover and restricted visibilities for protective concealment and as an element of surprise in both offensive and defensive maneuvers becomes increasingly important. Visibility restrictions, however, also hinder the mobility of military forces by impeding maneuverability and speed. For example, visibility restrictions encountered during Army helicopter nap-of-the-earth flights require that flight altitude be increased, thus enhancing the possibility of detection by the enemy, or that airspeed be reduced to provide more pilot reaction time for avoiding obstacles along the flight route.

As a visibility restrictor to air and ground operations, fog is extremely whimsical - covering particular locations (target areas and helicopter landing zones) without much warning or blanketing wide geographical areas for long periods of time. The conditions under which fog forms depend very much on the topography of the surrounding area and an adequate supply of suspended condensation nuclei in the atmosphere. The United States Army Aviation Digest [1] states: "even the advent of fog is an educated guess which could dissipate like magic if the temperature, dew point, or winds change."

This report presents an approach to the short-range prediction (in 3-hour periods) of restrictions in the surface visibility to less than 1 mile associated with the radiation fog process between midnight and sunrise. The approach recognizes the required cooling beyond saturation that is needed to provide enough condensed moisture to form fog (from a radiation fog prediction diagram presented by Petterssen [2]). Also considered are the physical process of nocturnal radiational cooling, "significant" changes ($\pm 3°F$) in temperature and dew point, and conditions favorable for the formation of radiation fog, i.e., little or no cloudiness and weak surface windspeeds.

Surface data used in the development of this approach are presented and preliminary prediction results are assessed.

RADIATION FOG

Studies conducted with visibility observations taken by the forward scatter visibility meter as part of a mesoscale forecasting experiment at Hanscom Air Force Base, Massachusetts [3], have shown that radiation fog conditions represent the most highly variable atmospheric situation and, consequently, are the most unpredictable in time and space.

The development of radiation fog depends on the cooling of the ground during the night. The air in contact with the ground is cooled by conduction. As the terrestrial radiation process continues, the cooling spreads upward assisted by a slight amount of mixing in the air adjacent to the earth's surface. The simplest example of a radiation type is afforded by ground fog. Ordinarily, ground fog is defined as a shallow but usually fairly dense fog through which the sky, moon, and stars are visible directly overhead.

Several types of pressure distribution, i.e., quiet anticyclonic conditions, an indefinite pressure distribution, or a col, may be associated with radiation fog; but all have one feature in common - a slack pressure gradient resulting in little surface wind. Hewson and Longley [4] state that radiation fog occurs most frequently in air of maritime origin after it has become stagnant over a cold continent.

Conditions favorable for the formation of radiation fog are: (1) a high relative humidity, so that little cooling is required to reach saturation; (2) little or no cloudiness, so that heat is lost by radiation from the ground; and (3) weak windspeed, so that cooling is confined to the surface layers and not spread thin by turbulent mixing.

In practice, suitable condensation nuclei are invariably present in large numbers. The main origin of the nuclei is probably the combustion products of domestic, factory, and other pollution sources. Sea salt particles may contribute about one-tenth of the nuclei involved in water droplet formation. Since the condensation nuclei are often hygroscopic (having a special affinity for absorbing water), they may cause water vapor condensation in the air even before saturation is reached, which explains why some fogs experienced by London and other large industrial cities occur with relative humidities near 90 percent [5].

The net nocturnal radiation from the ground is roughly proportional to the height of the clouds (Fig. 1). When the sky is covered with high clouds, the net loss of heat from the ground is almost as great as when the sky is clear. When the sky is covered with low clouds at an average height of 1.5 km, the net loss of heat from the ground is only about one-seventh as great as the loss when the sky is cloudless. Haynes [6] has indicated that with the lower types of clouds, especially those below approximately 3 km (10,000 feet) above ground level (AGL), radiational cooling from the ground will be prevented and the surface temperature will not reach the dew point, thus inhibiting the formation of ground fog.

To illustrate how windspeeds affect the formation of radiation fogs, Taylor [7] tabulated the frequencies of winds of various strengths on 70 occasions when night fog was reported at Kew Observatory near London, England, during the years 1900 to 1905. Taking the winds for 2000 Z (Greenwich Mean Time), which in most cases was before the fog had started

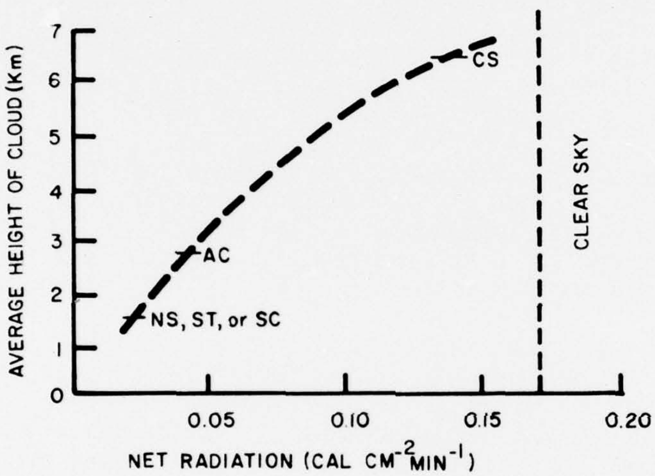


Figure 1. Nocturnal radiation with cloudy and clear skies [3].

to form, he found only two instances of speeds in excess of 2.5 meters sec^{-1} (4.9 knots); while in 50 cases, or 71 percent of the total number, the speeds were less than 1.5 meters sec^{-1} (2.9 knots).

If the dew point is reached first on the ground surface itself, moisture extracted from the air is deposited as dew. In quiet wind conditions, the cooling extends slowly upward and the surface becomes much colder than the air just above it. In such cases, the air just above the surface is progressively dried so that its dew point remains below the air temperature and fog does not form. However, when the air near the ground surface is subject to slight turbulent mixing, the cooling is spread upward and temperatures may fall below the dew point through an appreciable depth. Condensation then takes place within the air itself, resulting in the formation of ground fog.

With strong winds and well-developed turbulence, the loss of heat from the ground surface by radiation may be equally rapid, but the cooling is spread through a deep layer of air and temperatures fall slowly. Before mixing takes place, the humidity mixing ratio will ordinarily decrease with height. Vertical turbulent transfer of water vapor makes the distribution of mixing ratio more nearly constant with height [4]. There is a tendency for condensation at higher levels then, since the moisture content increases there; whereas there is less likelihood of condensation at lower levels where the moisture content decreases. Thus, turbulent mixing promotes the development of low stratus clouds, but retards the formation of fog.

If the air contains ample moisture, a delicate adjustment between the rate of cooling and the degree of turbulence is required to ensure that condensation shall occur in the air near the ground surface and not only on the ground as dew or above the ground as low clouds.

Radiation fog is erratic in its development - affecting one locality while leaving another clear when the differences in general meteorological conditions are otherwise unnoticeable. Tahnk [3] declared: "Our experiences with subjective forecasting during radiation fog episodes, even with a detailed network of continuously updated observational data, confirm that forecasting is generally an exercise in futility because of the chaotic and unpredictable nature of radiation fog."

DISCUSSION OF APPROACH

Background Information

Fog is formed through the condensation of water vapor from saturated air. Hewson and Longley [4] have stated that at least 0.5 gram of liquid water per kilogram of air must be present in the atmosphere before the visibility is reduced sufficiently to permit the classification of the condition as fog; that is, resulting in a reduction of

the horizontal range of visibility to less than 1,000 meters (0.6 statute mile). The authors [4] also report that with dense fog the amount of condensed water may be as much as 5.0 grams per kilogram of air.

Since the curve of saturation vapor pressure with varying temperature is not linear (Fig. 2), the amount of moisture which would condense for a 1-degree drop in temperature varies. Thus, for saturated air with a temperature of 30°C, the amount of cooling required to form fog is less than 1/2°C; while for saturated air with a temperature of 10°C, the cooling required is 1°C and for a temperature of -10°C, it is 3°C [4]. Hence, the amount of cooling necessary for fog formation is dependent upon the temperature of the air as well as the dew point depression.

Development of Approach

The purpose of this approach is to provide a prediction of a 3-hour period occurring between midnight and sunrise during which the formation process of radiation fog will initially restrict the prevailing surface visibility to less than 1 statute mile at the geographical location under consideration.

Experimental data used included available hourly and special surface weather observations within the Texas-Oklahoma-Arkansas-Louisiana area (Fig. 3) as reported between midnight and approximately sunrise during the period 25-28 February 1973. Geographical locations selected were those reporting weather conditions favorable for the formation of radiation fog, i.e., little or no cloudiness and surface windspeed less than 2.3 meters sec^{-1} (4.5 knots).

Synoptic weather conditions, i.e., surface pressure systems and frontal positions, valid for 0600 Z, i.e., 0000 Local Standard Time (LST), on each of the four days are shown in Fig. 4. In all instances, radiation fog formation was associated with a continental anticyclone (high pressure area).

Utilizing a radiation fog prediction diagram from which the amount of cooling necessary to produce a fog can be determined when the air temperature and the relative humidity are known (Fig. 5) as given by Petterssen [2], criteria were established for various temperatures to indicate the required cooling beyond saturation in order that the air should contain approximately 0.5 gram of liquid water per kilogram of air (Table 1). Conversion from the Celsius scale to the Fahrenheit scale has been made because utilized hourly aviation weather reports present surface temperature data in degrees Fahrenheit.

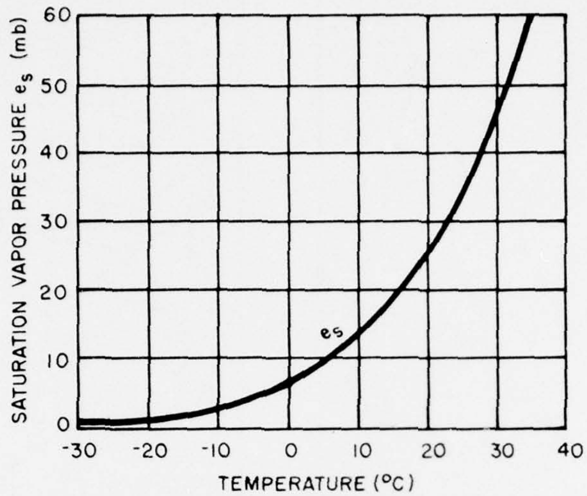


Figure 2. Variation of saturation vapor pressure with temperature.

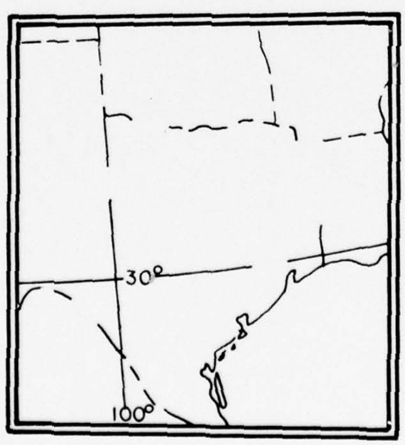
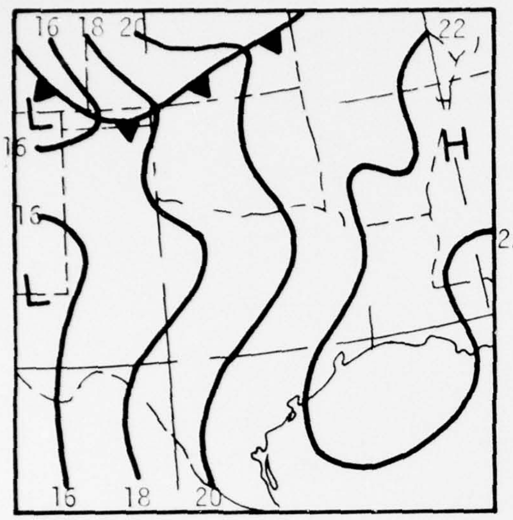
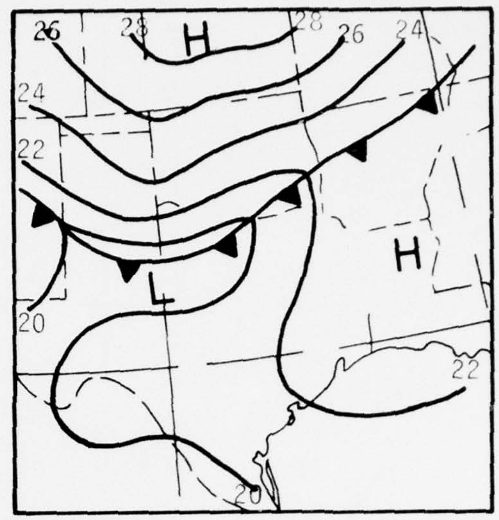


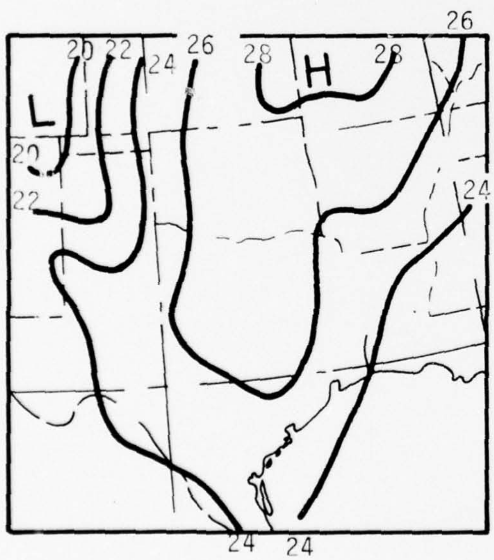
Figure 3. Area of Surface Weather Observations.



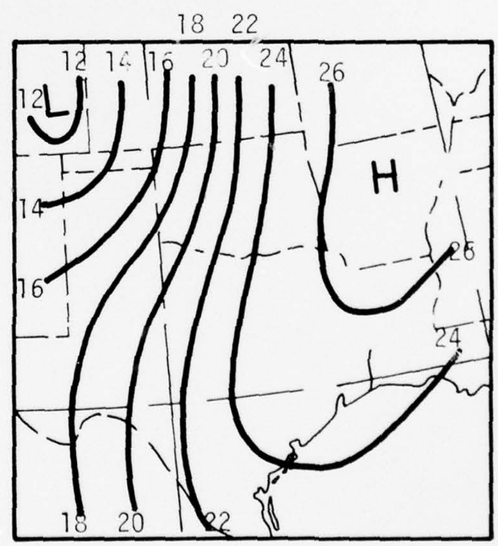
A. Map valid for 06 Z, 25 Feb 73



B. Map valid for 06 Z, 26 Feb 73



C. Map valid for 06 Z, 27 Feb 73



D. Map valid for 06 Z, 28 Feb 73

Figure 4. Analyses of Synoptic Weather Systems.

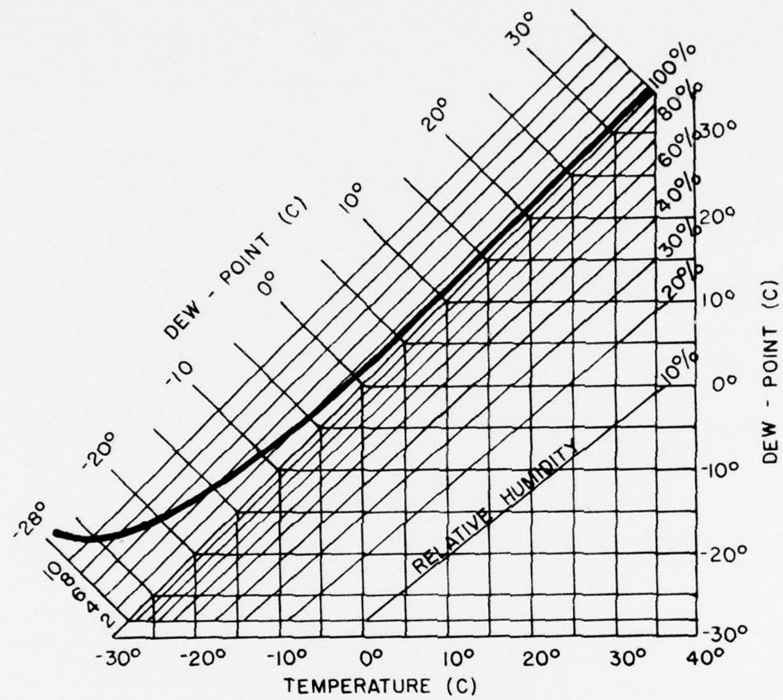


Figure 5. Fog Prediction Diagram.

TABLE 1

COOLING BELOW SATURATION REQUIRED FOR FOG FORMATION

Dew Point Temperature (F)*	Cooling Below Dew Point (F)*
>62	0
49 to 62	-1
30 to 48	-2
20 to 29	-3

*Fahrenheit Degrees

Procedure

Procedural steps established for this approach to the prediction of radiation fog are as follows:

Step 1. Locations reporting either a total overcast or obscured sky condition between the surface and 15,000 feet AGL or a surface windspeed of 4.5 knots or greater at 0000 LST are not selected.

Step 2. Beginning with the reported Fahrenheit temperature (T) at 0000 LST, subtract 1°F for each succeeding hour through 0700 LST to obtain extrapolated hourly temperatures due to radiational cooling (T_r).

Step 3. Obtain an initial fog formation temperature (T_f) by subtracting the required degrees of cooling for a specific range of dew point values (Table 1) from the reported 0000 LST dew point temperature (T_d).

Step 4. If the extrapolated T_r is equal to or less than T_f at any hour (H) between 0000 and 0700 LST, the predicted time period during the fog formation process when the surface visibility is initially restricted to less than 1 statute mile will be H - 1 to H + 2 hours.

Step 5. Hourly T_d measurements are cumulatively averaged between 0000 LST and the predicted H - 1 hour to obtain hourly T_f values. Whenever the average T_d value falls halfway between the two whole numbers, use the higher number.

Step 6. Reported total sky cover between the surface and 15,000 feet AGL are cumulatively averaged between 0000 and 0700 LST using a digital code of 0 = clear (CLR), 1 = scattered (SCT), 2 = broken (BKN), and 3 = overcast (OVC) or obscured (X).

Step 7. The reported surface windspeeds are cumulatively averaged between 0000 and 0700 LST.

Step 8. If at any hour T_r becomes ±3°F or greater than the reported T measurement, STOP and initiate the procedure again, using the reported T for that particular hour as a starting point. In this instance, averaged T_f values will continue to be used. If T is equal to or less than T_f, the predicted visibility restriction period will become H - 1 to H + 2 hours, using that particular hour as H hour.

Step 9. If at any hour T_f becomes ±3°F or greater than any preceding hourly T_f, STOP and initiate the procedure again, using the reported T and determined T_f values for that particular hour as starting points.

Step 10. If at any hour the averaged sky cover equals 3, a restricted visibility prediction is not applicable for that hour although no procedural interruption is effected at that time.

Step 11. If at any hour the averaged surface windspeed equals or exceeds 4.5 knots, a restricted visibility prediction is not applicable for that hour although no procedural interruption is effected at that time.

Step 12. When a prediction does not verify at the end of H + 2 hours through 0700 LST, an amendment is made by initiating the procedure again, using the data of the previously predicted H + 2 hours time as starting points. If the H + 2 hours time is beyond 0700 LST, no amended prediction is made.

RESULTS

Of a total of 52 cases, selected according to the criteria established under "Development of Approach," a verification of 71 percent was obtained in predicting the 3-hour period between midnight and sunrise during which the radiation fog process initially restricted the prevailing surface visibility to less than 1 statute mile (Table 2). Of the missed predictions, three failed to verify by less than 1 hour.

Hourly surface weather observations as reported for the 52 selected cases between 0600 Z (0000 LST) and 1500 Z (0900 LST) are presented in the appendix.

SUMMATION

Using only surface weather observational data, this effort has been an attempt to develop a simplified approach that can be easily adapted for rapid analysis and prediction of a time period when the radiation fog

TABLE 2

VERIFICATION RESULTS OF RADIATION FOG FORMATION PREDICTIONS

Date (1973)	Fog Predicted/ Fog Occurred (Cases)	No Fog Predicted/ No Fog Occurred (Cases)	Fog Predicted/ No Fog Occurred (Cases)	No Fog Predicted Fog Occurred (Cases)	Total (Cases)
25 Feb	11	5	4*	0	20
26 Feb	2	2	4	0	8
27 Feb	9	1	0	2	12
28 Feb	5	2	4**	1	12
Total	27	10	12	3	52
Percent	71%		29%		100

*Fog formed within one hour of predicted period: 1 case.
**Fog formed within one hour of predicted period: 2 cases.

formation process initially restricts the prevailing surface visibility to less than 1 statute mile. Although 71 percent verification was obtained from 52 test cases, this prediction approach must be tested more thoroughly in other geographical areas during other seasons of the year.

Martin [8] has previously pointed out that the time period (2 to 4 hours in advance) is frequently too extended to warrant a strict reliance upon persistency, yet too short for weather events to be captured by association with prognostic pressure or height features. The small-scale processes involved are highly dependent on thermal and moisture stratifications which are strongly influenced by the lower boundary of the atmosphere.

Temperature and moisture profiles in the surface boundary layer have not been considered in this approach because the representativeness of such data available from the tactical area is currently indeterminate. George [9] emphasized that various thermodynamic and kinematical properties, e.g., stability, state of the hydrolapse (vertical gradient of specific humidity), wind shear, and wind accelerations, are important in the formation of fog, and it is regrettable that there is not some frequent sampling of these properties through the lowest few thousand feet of the atmosphere. Perhaps ongoing work toward the development of sensors that describe vertical temperature and moisture profiles and measure liquid water content in the atmosphere may be a big step toward a solution to this problem.

Moschandreas and Leichter [10] have noted that perfect prediction will never be attained because forecasting does not simply depend on the level of understanding of meteorological phenomena but is also subject to various error sources that include: (1) gaps and errors in the initial state of the data in the observational network; (2) limitations in the objective analysis-initialization schemes which are applicable to the data; and (3) incomplete representation of the many dynamical processes in the atmosphere (uncertainties in parameterization).

Nevertheless, it appears that this approach may be of sufficient accuracy for utilization in military operations tactically affected by restricted visibilities related to the formation of radiation fog.

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APPENDIX

AVIATION WEATHER REPORTS

NOTE: Portions of the coded aviation reports included in this appendix are presented in accordance with the standard aviation report format for manned stations. Refer to page A4-13, Federal Meteorological Handbook No. 1, Surface Observations. (Sky cover abbreviations have currently replaced sky cover symbols in the reporting format.)

25 February 1973

Beeville, TX
(Fog Predicted 08-11Z)

06Z	CLR 5GF 51/49/0000
07	CLR 4GF 51/49/0703
08	CLR 4GF 0/49/0702
09	CLR 4GF 50/49/0703
10	-X 3/4GF 50/48/0000
11	-X 1/8F 48/48/0000
12	-X 1/8F 46/46/0701
13	-X 250 SCT 1/8GF 47/46/0402
14	-X 250 -BKN 1/4GF 49/47/0000
15	-X 250 -OVC 3/4GF 55/52/0501

Dyess AFB, TX
(No Fog Predicted)

06Z	CLR 15 41/38/0000
07	CLR 15 44/38/2802
08	CLR 15 42/37/2402
09	CLR 15 42/36/2101
10	CLR 15 40/35/2001
11	CLR 15 44/36/2205
12	CLR 15 47/37/2202
13	300 -SCT 15 40/34/0000
14	270 -BKN 20 41/36/0000
15	250 -BKN 20 46/41/0000

Alice, TX
(Fog Predicted 07-10Z)

06Z	CLR 7 51/50/0000
07	CLR 1GF 49/49/0000
08	-X 1/4GF 49/49/0000
09	-X 1/4GF 48/48/0000
10	-X 1/4GF 48/47/0000
11	-X 3/8GF 48/48/0000
12	CLR 1GF 49/48/0000
13	10 -BKN 3/4GF 49/48/0000
14	E18 BKN 4F 52/51/1102
15	E25 BKN 6GF 60/59/1308

Houston Int'l, TX
(Fog Predicted 08-11Z)

06Z	CLR 7 46/45/1502
07	CLR 7 44/44/0000
08	CLR 6GF 42/42/0000
09	CLR 6GF 41/41/0602
10	CLR 5GF 42/42/0000
11	CLR 1GF 40/40/0000
12	-X 3/4GF 40/40/0000
13	-X 1½GF 39/39/0000
14	-X 3/4GF 42/42/1003
15	-X 3/8F 49/49/1003

Ellington AFB, TX
(Fog Predicted 08-11Z)

06Z	CLR 11 46/45/0000
07	CLR 11 46/45/0000
08	CLR 11 45/44/0000
09	CLR 11 45/44/0000
10	-X 2GF 41/41/0000
11	CLR 5GF 41/41/0000
12	CLR 3GF 40/40/0000
13	-X 1/4GF 40/40/0202
14	-X 0F 44/44/0000
15	250 SCT 3GF 53/53/0904

McAlester, OK
(No Fog Predicted)

06Z	CLR 7+ 43/37/0000
07	25 SCT 6GF 39/36/0000
08	25 SCT 6GF 38/35/0000
09	CLR 7 38/35/0000
10	CLR 7 39/36/0000
11	CLR 7 38/35/0203
12	CLR 7 39/36/0000
13	CLR 6H 39/36/0000
14	250 -BKN 6H 41/39/0000
15	250 -SCT 6H 48/42/0000

Beaumont, TX
(Fog Predicted 07-10Z)

06Z	CLR 7 46/46/0000
07	CLR 7 45/45/0705
08	CLR 7 45/45/0000
09	CLR 6GF 43/43/0000
10	CLR 6GF 41/41/0000
11	CLR 3GF 43/43/0605
12	-X 1½GF 43/43/0704
13	-X 1/4GF 41/41/0000
14	-X 1/4GF 48/46/1003
15	2 SCT 3F 53/51/0905

Fort Smith, AR
(No Fog Predicted)

06Z	36 SCT 15 42/35/0000
07	40 SCT 15 40/36/0000
08	40 SCT 15 36/33/0000
09	CLR 15 33/29/0000
10	CLR 15 32/29/1003
11	CLR 15 31/29/0000
12	CLR 8 30/27/0704
13	M40 BKN 7 35/32/0103
14	M38 OVC 10 38/35/0705
15	M38 OVC 12 40/36/0804

Lake Charles, LA
(Fog Predicted 08-11Z)

06Z	CLR 5GF 46/45/0000
07	CLR 5GF 44/44/0000
08	CLR 4GF 44/43/0204
09	CLR 1GF 43/43/0505
10	CLR 1GF 43/42/0505
11	CLR 3/4GF 43/42/0000
12	CLR 1/2GF 42/42/0606
13	CLR 1/2GF 42/41/0607
14	CLR 1½GF 47/46/0605
15	CLR 6GF 52/49/0605

Lubbock, TX
(Fog Predicted 08-11Z)

06Z	CLR 10 37/36/0000
07	CLR 10 35/34/0000
08	CLR 10 35/34/3303
09	CLR 10 35/34/0000
10	CLR 4GF 34/33/0000
11	-X 1/2F 33/33/2703
12	-X 1/2F 34/32/2603
13	-X 1/8F 31/31/0000
14	-X 1/16F 31/30/3003
15	CLR 6GF 35/32/0000

Gage, OK
(Fog Predicted 08-11Z)

06Z	250 -SCT 35+ 39/35/0000
07	CLR 35+ 37/32/0000
08	CLR 35+ 35/31/2405
09	CLR 7 33/31/2505
10	CLR 3GF 34/32/2405
11	-X 1/4GF 32/30/2304
12	W0X1/16F 29/29/0000
13	W0X1/8F 30/28/0000
14	W1X1/16F 35/34/0000
15	W1X1/8F 37/36/0407

Altus, OK
(Fog Predicted 09-12Z)

06Z	CLR 10 44/42/1004
07	CLR 10 43/42/0903
08	CLR 10 43/42/0903
09	CLR 6GF 41/41/0704
10	-X 4F 41/41/0000
11	W2X4F 43/43/1003
12	W1X1/4F M/M/0000
13	W0X0F 44/44/0000
14	W1X1/16F 45/45/1003
15	W1X1/8F 46/45/0905

25 February 1973 (cont)

Little Rock, AR
(No Fog Predicted)

06Z	E80 BKN 12 46/41/1804
07	80 SCT 10 42/39/0000
08	CLR 10 40/37/2405
09	38 SCT 8 40/36/0000
10	40 SCT 8 39/36/0000
11	CLR 8 37/34/2505
12	CLR 8 37/34/2606
13	CLR 7 37/33/2506
14	CLR 7 40/37/2508
15	50 SCT 7 48/42/2504

Dalhart, TX
(No Fog Predicted)

06Z	CLR 25+ 39/24/0000
07	CLR 25 38/28/0000
08	CLR 15 36/29/0000
09	CLR 15 37/27/1606
10	CLR 15 31/27/1507
11	CLR 15 32/29/1606
12	CLR 15 31/29/0000
13	CLR 15 28/26/2807
14	CLR 12 25/23/3006
15	CLR 12 32/27/2705

Randolph AFB, TX
(Fog Predicted 08-11Z)

06Z	CLR 7 49/48/0000
07	CLR 5GF 49/47/2004
08	6 SCT 3F 45/43/0000
09	6 SCT 3F 42/40/3303
10	6 SCT 2F 40/39/3303
11	-X 3SCT 5/8F 40/38/3303
12	W1X1/4F 40/39/3303
13	W0X1/8F 43/42/3302
14	W1X3/16F 48/47/0000
15	W1X1/16F 50/49/0000

Kelly AFB, TX
(Fog Predicted 08-11Z)

06Z	CLR 15 50/48/1503
07	CLR 10 47/46/1602
08	6 SCT 4GF 48/47/0000
09	-X M7 BKN 17/8GF 44/43/0000
10	-X M6 BKN 17/8GF 44/43/0000
11	-X M4 OVC 1/4F 45/43/3401
12	-X M2 OVC 3/16F 47/46/0000
13	W2X1/16F 48/47/0000
14	W3X0F 49/48/0000
15	W3X1/8F 50/50/0000

Lufkin, TX
(Fog Predicted 10-13Z)

06Z	CLR 7 46/43/1104
07	CLR 7 44/42/1103
08	CLR 7 43/41/1303
09	CLR 7 44/43/1303
10	CLR 7 40/39/1004
11	CLR 1½GF 39/38/1003
12	CLR 1GF 39/37/0000
13	CLR ½GF 38/38/0000
14	CLR 1GF 43/42/0804
15	CLR 2GF 50/48/1106

Carswell AFB, TX
(Fog Predicted 11-14Z)

06Z	CLR 9 49/45/1204
07	CLR 8 48/44/1204
08	CLR 8 46/43/1203
09	CLR 9 45/44/0000
10	CLR 7 44/42/0000
11	CLR 4GF 43/42/0000
12	CLR 3GF 42/41/0000
13	W0X1/16F 40/39/0000
14	W1X0F 44/43/1706
15	-X M3 OVC 2½F 48/47/1607

Brownsville, TX
(Fog Predicted 11-14Z)

06Z	CLR 7 54/52/1204
07	CLR 7 54/52/1304
08	CLR 7 54/52/1205
09	CLR 7 54/52/1204
10	20 SCT 7 55/53/1205
11	CLR 7 54/52/1304
12	CLR 7 53/52/1403
13	20 SCT 7 53/52/1104
14	250 -BRN 7.58/57/1207
15	250 -BKN 7 65/61/1310

Kingsville, TX
(Fog Predicted 08-11Z)

06Z	CLR 5GF 53/51/1401
07	CLR 5GF 52/50/0000
08	CLR 4GF 51/49/0000
09	-X 3GF 49/47/0000
10	-X 1/8F 48/47/0000
11	-X 3/16F 48/47/0000
12	-X 3/4GF 48/46/0000
13	10 SCT 3/4GF 49/47/0000
14	E12 BKN 5GF 54/50/1202
15	250 BKN 7 62/57/1305

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Ellington AFB, TX
(Fog Predicted 06-09Z)

06Z	250 -SCT 3GF 49/49/0000
07	-X 3/8GF 44/44/0000
08	-X 5/8GF 42/42/0102
09	-X 1/2GF 44/44/0000
10	-X 100SCT 1/2GF 44/44/0000
11	-X 80SCT 5/8GF 44/44/0000
12	-X 60BKN 5/8GF 45/45/0000
13	-X 60 SCT 5/8GF 48/48/0000
14	60 SCT 2½GF 51/51/1403
15	CLR 5GF 59/57/1602

Houston, TX
(No Fog Predicted)

06Z	250 -SCT 5GF 51/49/1804
07	CLR 4GF 48/45/1004
08	CLR 5GF 48/45/0404
09	CLR 1GF 48/46/0604
10	250 -SCT 3GF 47/45/0604
11	50 -SCT 3GF 49/47/0604
12	50 SCT 3GF 49/47/0103
13	50 SCT 1½GF 51/48/0104
14	40 SCT 1½GF 54/51/1406
15	CLR 3K 62/55/0000

Beaumont, TX
(Fog Predicted 07-10Z)

06Z	250 -SCT 10 48/48/1903
07	250 -SCT 10 47/46/2703
08	CLR 10 46/46/0000
09	CLR 10 47/47/0000
10	CLR 10 44/44/0000
11	CLR 10 44/44/3607
12	CLR 4GF 44/44/0205
13	CLR 4GF 44/44/0704
14	CLR 2GF 49/47/0000
15	CLR 2GF 57/57/1304

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Houston Int'l, TX
(Fog Predicted 08-11Z)

06Z	CLR 6GF 45/44/0000
07	250 SCT 6GF 44/44/0503
08	CLR 2½GF 42/42/0000
09	-X 1GF 41/41/0000
10	55 SCT 1GF 41/41/0502
11	2 SCT E45 BKN 1F 43/43/0000
12	2 SCT E50 BKN 1½F 45/45/0402
13	50 SCT E80 BKN 1½GF 49/49/1805
14	50 SCT 1½GF 50/50/3204
15	50 SCT 1GF 57/55/0000

Lake Charles, LA
(Fog Predicted 07-10Z)

06Z	CLR 7 50/49/0000
07	CLR 2GF 48/48/0000
08	-X 1/2GF 46/46/3303
09	W1X1/8F 47/47/0000
10	W1X1/8F 45/45/0000
11	W1X1/8F 44/44/3104
12	-X 3/4GF 44/44/3205
13	MISG
14	CLR 1GF 50/49/0000
15	CLR 1½GF 54/52/0904

Lufkin, TX
(Fog Predicted 08-11Z)

06Z	250 SCT 7 49/48/1204
07	CLR 13 47/45/1604
08	CLR 13 46/45/0000
09	CLR 13 43/42/0000
10	30 SCT 13 47/46/1406
11	30 SCT 13 49/44/1606
12	CLR 13 44/42/0000
13	40 SCT 7 47/45/0000
14	100 SCT 7 50/47/0000
15	E80 BKN 7 60/47/2010

Barksdale AFB, LA
(No Fog Predicted)

06Z	CLR 7 48/45/0000
07	CLR 7 47/45/0000
08	CLR 7 47/44/1802
09	80 SCT 7 48/46/1604
10	CLR 6GF 46/45/1504
11	R70 BKN 5GF 46/45/1503
12	70 SCT 4GF 48/46/1303
13	E50 BKN 170 OVC 3GF 47/46/3504
14	E40 OVC 2R-GF 49/48/0203G11
15	R50 BKN 100 OVC 3GF 50/50/1605

Lafayette, LA
(Fog Predicted 09-12Z)

06Z	CLR 7 49/47/0000
07	CLR 7 48/45/0000
08	CLR 7 48/46/0000
09	CLR 7 47/44/0000
10	CLR 7 45/43/0000
11	CLR 6GF 43/41/0000
12	CLR 6GF 44/42/0000
13	CLR 4GF 44/43/0000
14	CLR 5GF 51/47/0000
15	CLR 6KH 59/47/3107

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Mineral Wells, TX
(Fog Predicted 08-11Z)

06Z	CLR 4GF 39/38/0000
07	CLR 3GF 39/39/0000
08	-X 2GF 38/38/0000
09	-X 1/2F 36/36/0000
10	WOXOF 35/35/0000
11	WOXOF 34/34/0000
12	WOXOF 35/35/0000
13	WOXOF 34/34/0000
14	WOXOF 36/36/0000
15	WOXOF 39/38/2204

Wichita Falls, TX
(Fog Predicted 07-10Z)

06Z	CLR 4GF 38/38/1904
07	CLR 4GF 38/38/2103
08	-X 3F37/37/2003
09	-X 1/2F 34/34/0000
10	WOX1/8F 34/34/0000
11	-X 1/8F 34/34/2104
12	-X 1/16F 34/34/1803
13	WOX1/16F 32/32/0000
14	WOXOF 34/34/0000
15	WOXOF 36/36/0000

Oklahoma City, OK
(Fog Predicted 08-11Z)

06Z	CLR 4GF 34/33/0000
07	CLR 4GF 33/32/1504
08	-X 3/4GF 30/30/0000
09	-X 3/8GF 30/28/1403
10	-X 3/16GF 28/28/0000
11	-X 1/2GF 29/28/0000
12	-X 1/4GF 29/28/1204
13	-X 1/16F 30/29/1604
14	W1X1/16F 31/30/1406
15	W1X1/8F 37/34/1307

Ardmore, OK
(Fog Predicted 09-12Z)

06Z	-X 3GF 36/34/0000
07	-X 3GF 34/32/0000
08	-X 3GF 34/32/0000
09	-X 1GF 32/30/0000
10	-X 3/4GF 32/30/0000
11	-X 1/4GF 30/29/0000
12	-X 1/4GF 30/29/0000
13	WOXOF 30/29/0000
14	WOX1/4F 31/29/0000
15	-X 3/8F 35/34/0000

San Angelo, TX
(Fog Predicted 07-10Z)

06Z	CLR 4GF 38/38/1403
07	CLR 4GF 39/39/2204
08	CLR 4GF 38/38/0000
09	WOXOF 34/32/0000
10	WOX1/8F 34/34/0000
11	WOX1/8F 34/34/0000
12	WOX1/8F 34/34/2304
13	-X 1/8F 34/34/2204
14	M15 BKN 1F 35/33/2604
15	M17 OVC 5F 39/37/0000

Dallas, TX
(Fog Predicted 10-13Z)

06Z	CLR 4H 43/40/3003
07	CLR 3GF 42/40/3104
08	CLR 3GF 42/40/3305
09	CLR 3GF 41/39/3606
10	CLR 3GF 39/37/3004
11	WOXOF 37/35/3303
12	WOXOF 37/37/2904
13	WOXOF 38/38/3304
14	WOXOF 39/39/3303
15	W2X1/4F 39/39/3603

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Lubbock, TX
(Fog Predicted 11-14Z)

06Z	CLR 15 41/37/1604
07	CLR 12 41/37/1805
08	CLR 12 40/37/1805
09	CLR 12 38/36/1705
10	CLR 12 37/35/2205
11	CLR 3GF 36/35/2503
12	CLR 2GF 35/35/1804
13	-X 2GF 34/34/0000
14	-X 250 BKN OF 33/33/2804
15	WOXOF 34/34/0000

Fort Sill, OK
(No Fog Predicted)

06Z	CLR 6GF 37/34/0000
07	CLR 3GF 38/35/0000
08	CLR 3GF 38/35/0000
09	-X 3/4F 34/32/0000
10	-X 1/4F 34/31/0000
11	WOXOF 35/34/0000
12	WOXOF 35/33/0000
13	WOXOF 36/34/0000
14	WOXOF 35/35/0000
15	WOXOF 38/37/2203

Tinker AFB, OK
(No Fog Predicted)

06Z	CLR 7 36/33/0000
07	CLR 5GF 36/34/1103
08	CLR 4GF 37/34/1402
09	-X 13/4GF 34/32/0000
10	-X 1½GF 34/32/0000
11	-X 1½GF 36/34/1102
12	-X 1GF 35/33/1403
13	-X 250 SCT 3/4GF 35/33/1203
14	-X 250 SCT 1/8GF 34/32/1103
15	-X 250 SCT 1/4GF 37/35/1006

Dyess AFB, TX
(No Fog Predicted)

06Z	CLR 8 39/34/0000
07	CLR 8 36/32/1602
08	CLR 20 36/32/0000
09	CLR 8 34/30/0000
10	CLR 7 34/30/0000
11	-X 1½GF 35/32/1602
12	CLR 2½GF 33/30/0000
13	CLR 2GF 34/30/0000
14	-X 250 SCT 11/4GF 35/31/2302
15	-X 300 -BKN 1½GF 42/38/1703

Altus, OK
(Fog Predicted 07-10Z)

06Z	CLR 6GF 36/36/0000
07	CLR 3GF 35/35/0000
08	-X 0GF 35/35/0000
09	WOXOF 34/34/0000
10	WOXOF 33/33/0000
11	WOXOF 33/33/0000
12	WOXOF 33/33/1904
13	WOXOF 33/33/0000
14	WOXOF 34/34/1603
15	WOXOF 37/37/1904

McAlester, OK
(Fog Predicted 09-12Z)

06Z	-X 3GF 37/35/0000
07	-X 3GF 34/32/0000
08	-X 3GF 35/33/0503
09	-X 3GF 33/32/0000
10	-X 2GF 32/30/0903
11	-X 2GF 31/29/0000
12	-X 1/2GF 31/29/0803
13	-X 1/16F 32/31/0703
14	WOX1/16F 33/31/0906
15	W7X1F 37/36/0906

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Lufkin, TX
(Fog Predicted 12-15Z)

06Z	CLR 7 43/42/0000
07	CLR 8 41/40/0000
08	CLR 8 43/41/0000
09	CLR 8 44/43/0604
10	CLR 4GF 44/43/0605
11	CLR 4GF 44/43/0705
12	CLR 3GF 41/40/0604
13	CLR 1½GF 41/40/0604
14	CLR 1½GF 45/44/0906
15	CLR 4GF 49/46/0907

Ellington AFB, TX
(Fog Predicted 08-11Z)

06Z	CLR 5GF 48/47/3102
07	CLR 4GF 49/49/0000
08	CLR 2½GF 46/45/0000
09	-X 7/8GF 46/46/0000
10	-X 11/8GF 44/44/0000
11	-X 1/16GF 40/40/0000
12	-X M2 BKN 3/8F 43/43/0000
13	WOXOF 44/44/0000
14	WOXOF 48/48/0000
15	-X 1-SCT 11/8F 52/52/0704

College Station, TX
(Fog Predicted 08-11Z)

06Z	CLR 6H 45/44/0000
07	CLR 5GF 46/45/0505
08	CLR 5GF 43/42/0000
09	CLR 3GF 44/44/1304
10	CLR 4GF 45/44/0000
11	CLR 3GF 42/42/0000
12	-X 1/2F 40/39/0000
13	WOXOF 43/43/0000
14	WOXOF 48/48/0000
15	W1X1/16F 46/46/0000

Houston Int'l, TX
(Fog Predicted 07-10Z)

06Z	CLR 6GF 44/44/3003
07	CLR 5GF 43/43/0000
08	CLR 4GF 41/41/0000
09	CLR 3GF 40/40/0000
10	-X 1GF 40/40/3002
11	-X 1/4GF 39/39/0000
12	-X 1/16F 39/39/0000
13	-X 1/16F 40/40/0503
14	W1X3/16F 42/42/0904
15	-X 3 SCT 1½GF 46/46/0806

Shreveport, LA
(No Fog Predicted)

06Z	CLR 7 45/40/0000
07	CLR 7 44/39/0000
08	CLR 6HK 42/38/0000
09	CLR 4HK 42/38/0000
10	CLR 3HK 40/37/0000
11	W1X3/8F 41/38/0806
12	W1X1/4F 40/38/0805
13	W1X1/4F 40/38/1107
14	W1X3/4F 40/38/0807
15	M30 OVC 1F 41/39/0905

Barksdale AFB, LA
(Fog Predicted 08-11Z)

06Z	CLR 3GF 43/42/0000
07	CLR 1½GF 41/40/0000
08	CLR 2GF 40/39/0000
09	CLR 2GF 39/39/0000
10	-X 1/16F 36/36/0703
11	W2X1/8F 39/39/0904
12	W2X1/4F 39/39/0904
13	W3X1/2F 40/40/0705
14	-X M3 OVC 7/8F 40/40/0906
15	-X M4 OVC 1F 40/40/1206

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Longview, TX
(Fog Predicted 10-13Z)

06Z	250 SCT 5GF 45/42/0000
07	CLR 5GF 44/41/0805
08	CLR 5GF 43/41/0705
09	CLR 2½GF 43/41/0804
10	CLR 2½GF 43/41/0104
11	CLR 2½GF 41/39/1205
12	CLR 1GF 40/38/1305
13	WOXOF 41/40/1205
14	WOXOF 41/40/0605
15	W1X5/8F 41/40/0709

Houston, TX
(Fog Predicted 10-13Z)

06Z	CLR 5K 50/47/3204
07	CLR 4GF 50/47/3405
08	CLR 3GF 49/46/3303
09	CLR 2½GF 49/47/3204
10	CLR 3GF 47/43/0000
11	CLR 3GF 47/44/0000
12	-X 1GF 45/43/0000
13	WOXOF 45/43/0000
14	WOXOF 50/48/0905
15	W1X1/4F 52/50/0806

Fort Sill, OK
(Fog Predicted 09-12Z)

06Z	-X 4GF 45/43/1603
07	-X 250 SCT 4GF 44/42/1704
08	-X 3GF 44/42/1505
09	-X 2GF 43/41/1605
10	-X 1¼GF 42/40/1604
11	-X1/2F 40/40/1506
12	W3X1/4F 41/41/1508
13	W4X1/2F 42/42/1709
14	W5X3/16F 43/43/1610
15	-X M3 OVC 1F 44/44/1709

McAlester, OK
(No Fog Predicted)

06Z	CLR 7 48/41/0000
07	CLR 7 47/42/1703
08	CLR 7 45/42/1803
09	CLR 7 45/42/1907
10	CLR 7 44/42/1904
11	CLR 7 42/40/0000
12	CLR 7 43/40/1605
13	B9 OVC 2F 43/41/0000
14	E9 OVC 2F 44/42/0000
15	B7 OVC 2F 45/42/1708

Waco, TX
(Fog Predicted 07-10Z)

06Z	CLR 5GF 42/42/0000
07	CLR 4GF 42/42/1504
08	CLR 4GF 41/41/1105
09	CLR 4GF 43/41/0000
10	CLR 4GF 43/43/0000
11	-X 3F 38/38/0000
12	CLR 3GF 40/40/0000
13	WOXOF 37/37/0000
14	WOXOF 40/40/0000
15	WOXOF 44/44/1808

Little Rock, AR
(No Fog Predicted)

06Z	CLR 5GF 35/31/1204
07	CLR 4GF 35/31/0804
08	M13 OVC 4GF 33/30/1903
09	M12 OVC 4GF 35/31/0906
10	12 SCT 4F 32/29/1105
11	12 SCT 4F 31/27/1004
12	12 SCT 3F 31/27/0904
13	250 SCT 3GF 30/26/1203
14	12 SCT250 SCT 1½F 33/29/0905
15	M6 OVC 1¼F 34/30/0807

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